

Nondefense
Discretionary Science

2013 Survey

Unlimited

Vanishing Opportunity

Potential

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Introduction



The United States' scientific research enterprise has propelled Americans to the moon, launched the Internet and sequenced the human genome. The vibrant culture of freedom and curiosity that abounds in the U.S. has produced astounding breakthroughs in every field of science, from astrophysics to zoology. A strong, sustained federal investment in scientists and the groundbreaking research they conduct has been the backbone of this enterprise.

Smartphones, global positioning systems, satellite television and magnetic resonance imaging are but a few examples of how the U.S. federal investment in scientific research shapes the world around us. The technological innovations underlying these inventions were not derived in the labs of corporations. Rather, research funded by the federal government through the National Science Foundation, the National Aeronautics and Space Administration, the Defense Advanced Research Projects Agency and others gave scientists and engineers working in the U.S. the necessary tools and freedom to explore the important scientific questions that made these technologies possible.

Furthermore, federal investments in biomedical research through the National Institutes of Health, the Centers for Disease Control and Prevention, the Food and Drug Administration and others, have resulted in a steadily increasing life expectancy for Americans. From the invention of vaccines and the prevention of myriad diseases to the most recent advances in molecular medicine, federally funded biomedical research saves lives. Research that saves the lives of cancer, HIV and Alzheimer's patients; prevents heart attacks, strokes and diabetes; and treats congenital disorders, sickle-cell anemia and bacterial infections, was, at one point, funded by the federal government and conducted in American laboratories.

Research labs are to the national scientific enterprise what small businesses are to the American economy. Individual labs, funded by

federal grants for research, employ young scientists and make the discoveries that tech companies capitalize on. Corporations like Apple, Pfizer and Boeing, to name a few, have built their success on pioneering discoveries made by federally funded scientists working at American universities. This pipeline of discovery and commercialization pays real dividends for the American taxpayer—research in American labs and commercialized by American companies leading to a 1 percent drop in the yearly cancer mortality rate saves the U.S. \$500 billion per year in health care costs. The information technology sector, built largely on discoveries made by federally funded scientists, contributes nearly \$1 trillion per year to the U.S. gross domestic product. Thus, the federal investment in scientific research has been, and continues to be, repaid to the U.S. government and the American taxpayer many times over.

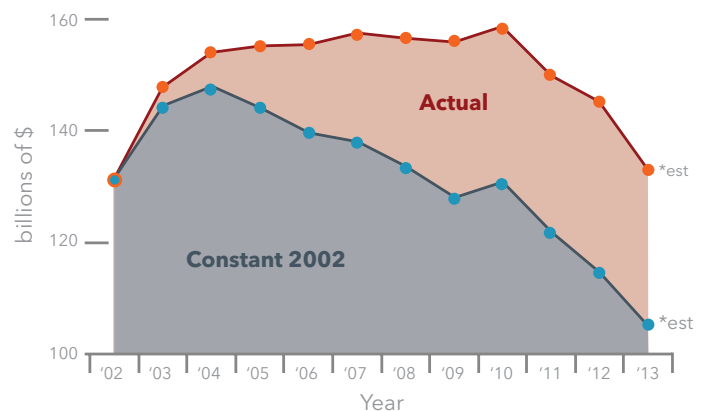
However, over the past 10 years, the federal investment in research and development has faltered. Federal investments in scientific research have been stagnant and have failed to keep pace with inflation. Furthermore, sequestration and other budget cuts to federal agencies have eroded our ability to invest in the next generation of scientists to carry out the groundbreaking research the U.S. is known for. These trends must be reversed in order for American scientists to continue to make the discoveries that improve our lives. An enduring federal investment in scientific research is essential to continue to enrich the lives of Americans for decades to come.



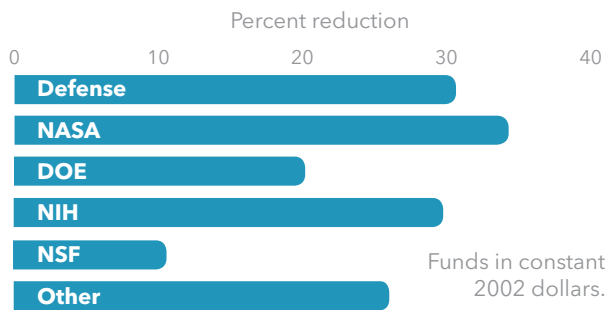
History

The federal investment in scientific research has been the foundation for the discovery and development of groundbreaking technologies that have reshaped how we interact with one another and the world. However, over the past 10 years, federal funding for scientific research, in terms of real dollars, was mostly flat. When inflation is taken into account, the federal investment in science has declined steadily since 2004, having suffered a nearly 30 percent reduction.

Federal R&D investments since 2002



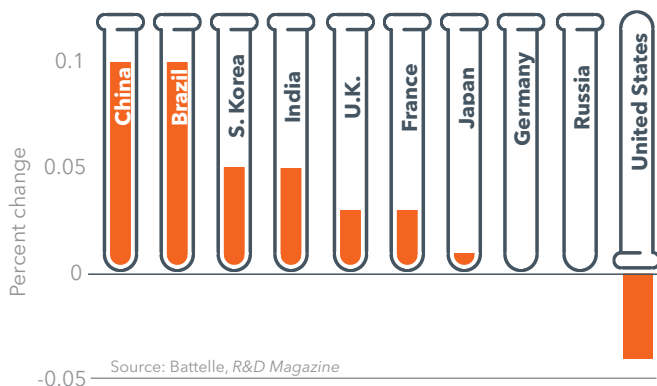
Reduction in agency funding since 2004



The reduction in the federal investment in scientific research has affected all federal research funding agencies. While the budgets of most research funding agencies have remained flat, inflation has caused a 20 to 30 percent reduction in purchasing power at each agency since 2004. The exception is the National Science Foundation, which has experienced only a 10 percent reduction in purchasing power due to an increase in real dollars from 2008 through 2012.

Source: AAAS

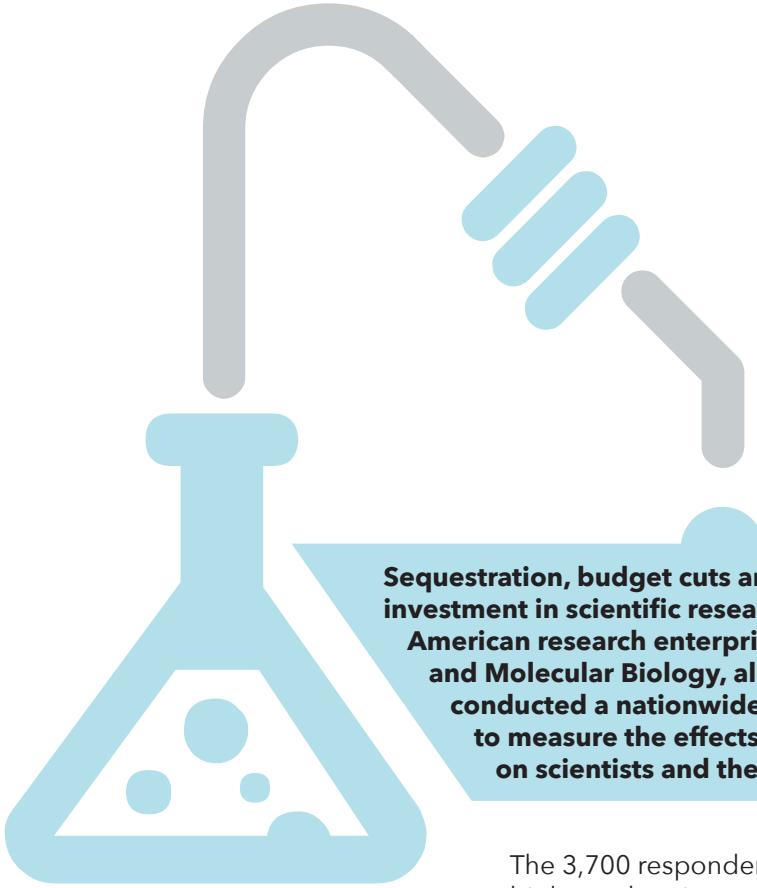
Change in percentage of GDP invested in research since 2011



Source: Battelle, R&D Magazine

Globally, the United States invests more real dollars in research and development than any other country. However, in terms of percentage of gross domestic product, the United States is reducing its investment in scientific research. In fact, of the 10 countries investing the most money in scientific research, the United States is the only country that has reduced its investment in scientific research as a percentage of GDP since 2011.

Themes



Sequestration, budget cuts and the recent downward trends in the federal investment in scientific research have had a detrimental effect on the American research enterprise. The American Society for Biochemistry and Molecular Biology, along with 15 other science organizations, conducted a nationwide, online survey during June and July of 2013 to measure the effects of the faltering federal investment on scientists and the research they are trying to conduct.

The 3,700 respondents spanned nearly all scientific fields including biology, chemistry, physics, geosciences, engineering, mathematics, economics, computer science, education, political science and social and behavioral sciences. The concerns of the participating scientists focused on four specific areas:

- **The benefits of scientific research:** Scientific research has improved our lives in innumerable ways. However, budget cuts to federal science funding agencies means that some of the research that will uncover new technologies and disease treatments may be postponed indefinitely.
- **The next generation of scientists:** The determination and creativity of young scientists lead to many of the innovative discoveries made in the U.S. However, the decline in the federal investment in research makes it extremely difficult for young scientists to start and continue careers in science causing the American research enterprise to become less dynamic and less productive.
- **The loss of federal investment:** The federal government invests in the training of young scientists. However, as budget cuts force people to abandon scientific careers, the federally funded scientific infrastructure goes unused and the federal investment in the training of young scientists is lost.
- **U.S. global research leadership:** Countries around the world are increasing their investments in scientific research, while the purchasing power of U.S. science funding agencies is declining. Budget cuts to federal science funding agencies have put the American position as a global leader in research and innovation in jeopardy.



Benefits of Scientific Research

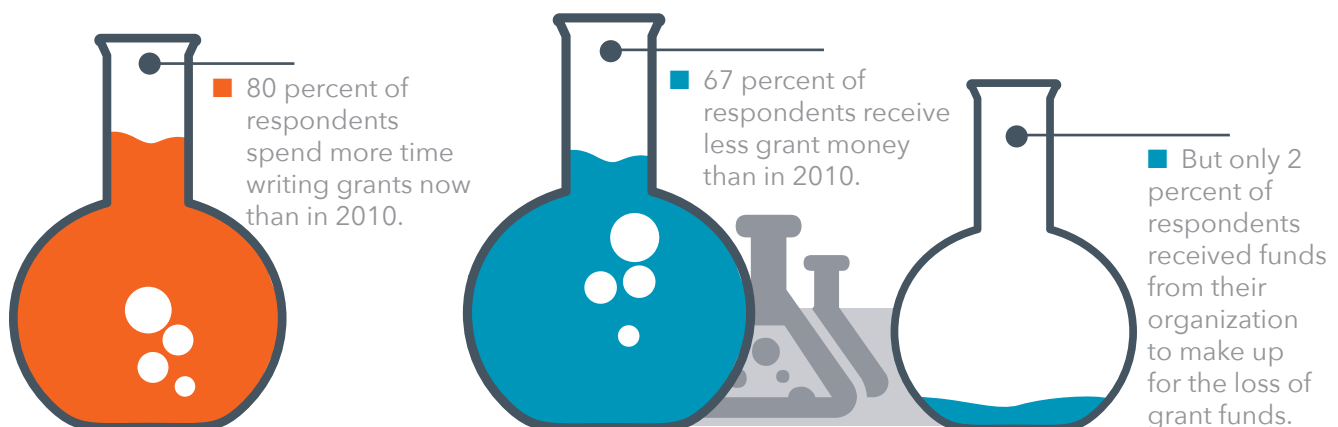
The federal investment in scientific research benefits all Americans

"One example of cutbacks at my institution is a loss of funding for the landmark Framingham Heart Study, which began in 1948 and has followed two generations since. This study has provided much of the basic knowledge about cardiovascular health and disease that we have. We will lose any further valuable insights from such a long-term study, and such a perspective will be impossible to regain."

Faculty biologist from Massachusetts

Academic labs are the small businesses of scientific research. Grants from federal science funding agencies allow labs to hire highly skilled scientists and engineers who conduct groundbreaking research, thereby providing the seed material for companies to develop new technologies and therapies. However, sequestration and the stagnant federal research budget threaten this model. The vast majority of respondents to our survey indicated they spend more time writing grants now than they did in 2010. Despite this,

most respondents receive less grant funding now than they did three years ago. This drain of grant funds significantly hinders the small businesses of scientific research, which affect tech companies and the overall U.S. economy. When asked which research fields would be most damaged by the stagnant federal budget, survey respondents indicated several fields including technology and drug development and research into cancer and alternative forms of energy.



Climate Change Cancer Neurodegenerative Diseases Technology and Drug Discovery Metabolic Diseases Infectious Diseases Alternative Energy

Respondents stated many research areas are adversely affected by federal budget cuts. Font size reflects number of survey comments.

Scientists speak about federal budget cuts and the benefits of scientific research

"New research fuels industry growth. In pharmaceutical product development, industry is cutting back putting more pressure on innovative medical research from the government and other funding (sources). Cutbacks in government funding will limit new medical breakthroughs that are needed to fight disease as well as find products that will reduce medical costs."

– Senior Director of research and development from a biochemistry company in Illinois

"The lack of research in immunotoxicology, environmental health and immunology will affect the safety of all of the new biological drugs being made, especially immune system modulators, and will affect studying the mechanism ... of environmental insults, such as pesticides, allergens, air pollution and heavy metals like mercury and cadmium, affecting the study of autism, asthma and cancer research."

– Assistant Professor from the Public Health Research Institute in New Jersey

"The poor funding climate impacts target and drug discovery in many aspects of biomedical research, including those that have a huge impact on our economy, such as type 2 diabetes, cardiovascular disease and chronic forms of neurodegeneration such as Alzheimer's."

– Adjunct Associate Professor from the University of California, San Diego

"We have preliminary data that is truly transformative with the potential to lead to (millions to billions of dollars) in economic stimulus in the sustainable energy field, but our research doesn't fit into (Advanced Research Projects Agency-Energy) or other proposals because we have succeeded in a completely new area that my lab has created."

– Faculty biologist from Nebraska

"We have promising novel therapeutics for a neurological/neuropsychiatric disorder; without funding, we cannot move it beyond the preclinical phase."

– Faculty biologist from New Jersey



Next Generation of Scientists

The federal investment in scientific research creates jobs

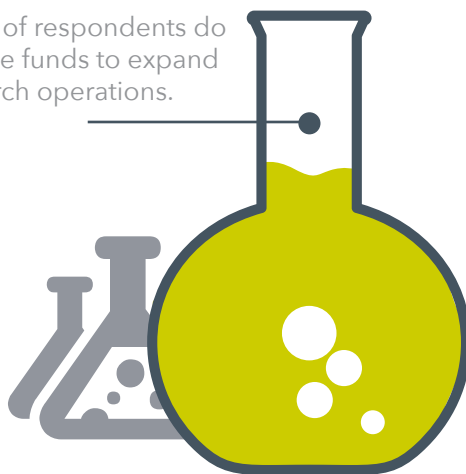
"This funding environment can't be sustained much longer. The dearth of funding will have secondary effects on education, launching of new biotechnology companies and sales of scientific supplies. Jobs will be lost, and talented people will need to find employment that does not take advantage of their knowledge or experience."

Professor from the New York University School of Medicine

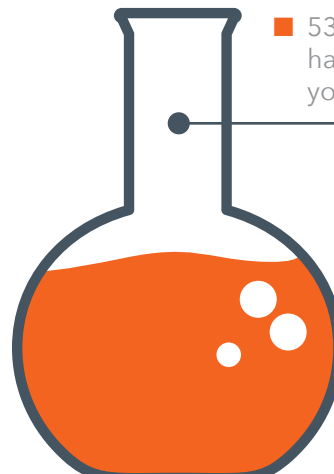
A single federal grant for scientific research employs 2 to 8 highly trained scientists. Sequestration and federal budget cuts have eliminated jobs for scientists by significantly reducing the number of grants awarded by science funding agencies. Furthermore, this prevents labs from probing new scientific questions. Two-thirds of survey respondents do not have the funds to expand their research operations,

thereby curtailing the number of exciting scientific questions that they can pursue. More than half of the survey respondents have turned away young researchers interested in working in their labs. An academic lab that receives a federal grant can create jobs and expand their research capabilities. Labs that lose grants must eliminate jobs, thereby hindering the nation's scientific progress.

■ 68 percent of respondents do not have the funds to expand their research operations.



■ 53 percent of respondents have turned away promising young researchers.





Scientists speak about budget cuts and the risk to jobs in research

"It is disheartening to be at the start of what I hope will be a strong and successful scientific career and have to wonder if I will even get a job, be able to fund my research and have hope of being a competitive scientist."

– Graduate student from California State University, Fullerton

"Students have lost access to internships with the U.S. Geological Survey and the U.S. Forest Service. Positions were cancelled."

– Faculty geoscientist from Colorado

"As a small primarily undergraduate institution, the cutbacks have an indirect effect (on us). We can maintain small research projects without extramural funding, but the increasing difficulty makes it difficult to provide quality research opportunities for all students who want one, which negatively impacts our ability to train the next generation of scientists. This training mission is our principal contribution to the national scientific enterprise."

– Faculty chemist from Tennessee

"As a department chair, I have several recently promoted associate professors who were well funded as assistant professors, have excellent publication records and are doing exciting, groundbreaking biomedical research. All of them are struggling to obtain renewed funding for their successful research projects. If they go for several years without getting grants, their research careers will be effectively over, and we will have lost their research talents from the pool of active scientists."

– Professor from the University of Southern California

"All American universities rely on scientific agencies to fund academic research, meaning cuts to these budgets eliminate training in research. We cannot afford, as a nation, to go forward without a trained cadre of (science, technology, engineering and mathematics) professionals."

– Assistant Professor from Dakota Wesleyan University in South Dakota



Loss of Federal Investment

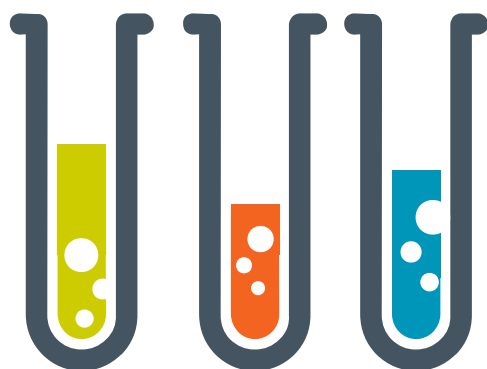
Protect the investment the government has already made

"I am amongst a growing list of scientists that the federal government has spent \$200,000 to \$400,000 to educate and train since the early 1990s. The expectation was that we would have the opportunity to show U.S. taxpayers a return on their investment by becoming (science, technology, engineering and mathematics) leaders and innovators far into the middle of the 21st century. Unfortunately, the current funding climate presents the real possibility that the taxpayers may witness a significant loss in their investment."

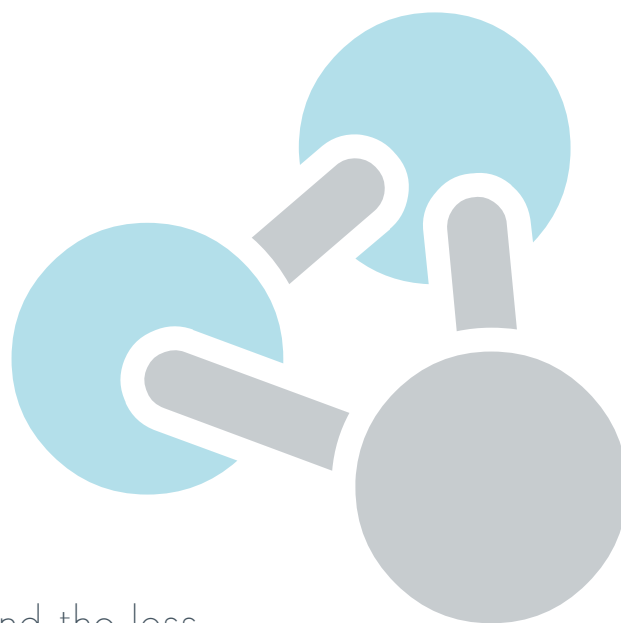
Postdoctoral scholar from the University of Pennsylvania

Through grants from federal science funding agencies, the federal government invests significantly in training young people to become rigorous scientists and engineers equipped with the skills necessary to make important discoveries. However, due to sequestration and other budget cuts, scientists are being forced to leave the fields they've trained so hard for, representing a loss of the government's training investment. Due to the difficulty in receiving federal grants, nearly half of the survey respondents report having been laid off or they expect to be laid off in the near future.

Similarly, over half of survey respondents have a colleague who has lost or expects to lose his/her job soon. Every scientist who loses the chance to have a research career represents a significant loss in the federal training investment and a lost opportunity to make the next groundbreaking advance. Scientific research pays significant dividends to the American taxpayer, and the federal investment in research must be maintained to ensure the American people continue to reap these benefits.



- 65 percent of respondents have had difficulties receiving funding.
- 46 percent of respondents have laid off scientists or expect to soon.
- 55 percent of respondents have a colleague who has lost a job or expects to soon.



Scientists speak about budget cuts and the loss of the federal investment in scientific research

"Science is a special enterprise ... to help society and foster international collaboration. This is a good place to put our investment dollars."

– Faculty biologist from New York

"The people of the U.S. are justifiably proud of the number of Nobel Prizes that come to the U.S. ... (These prizes reflect) the far-sighted policies of earlier governments who provided funding for people with ideas."

– Professor from The Scripps Research Institute in California

"I, like many others, was trained for years to a high level thanks to taxpayer's money that enabled my research to be funded both in my home country and here in the U.S.A. during my postdoctoral training. It is a privilege to have had the opportunity. However, those same taxpayers are losing out on their investment in my training because, without more funding, I will be unable to pay them back by contributing to further scientific discovery."

– Postdoctoral scholar in biochemistry from Washington

"Talented, trained scientists will have to leave research, which will have a devastating impact on existing expertise in the field. Significant funds have been spent training these people; as they leave, those investments will have gone to waste."

– Postdoctoral scholar in biology from Massachusetts



U.S. Global Leadership

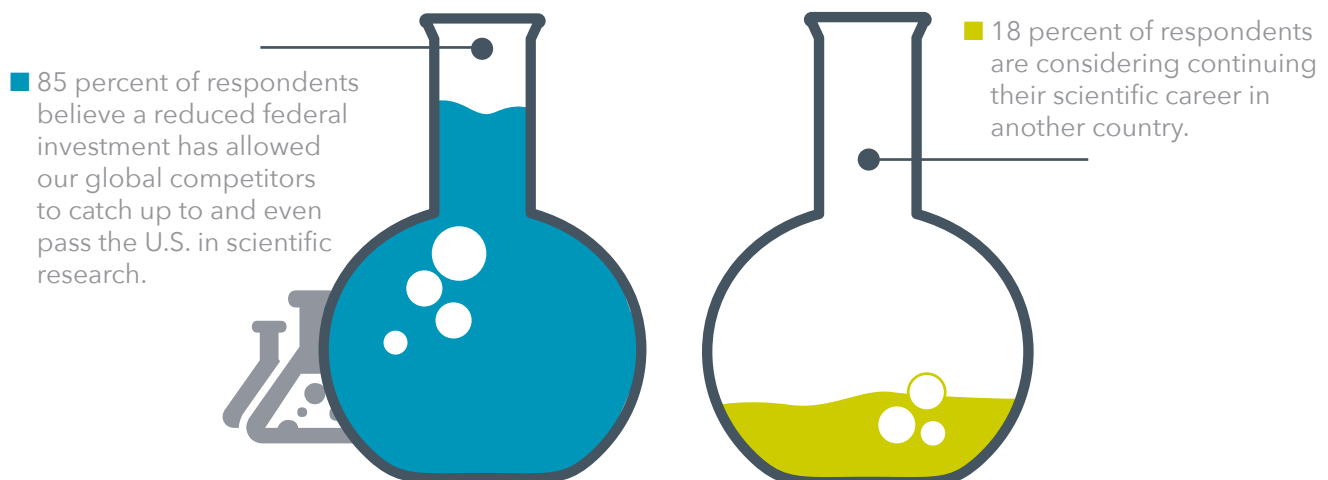
The federal investment in scientific research ensures U.S. global research dominance

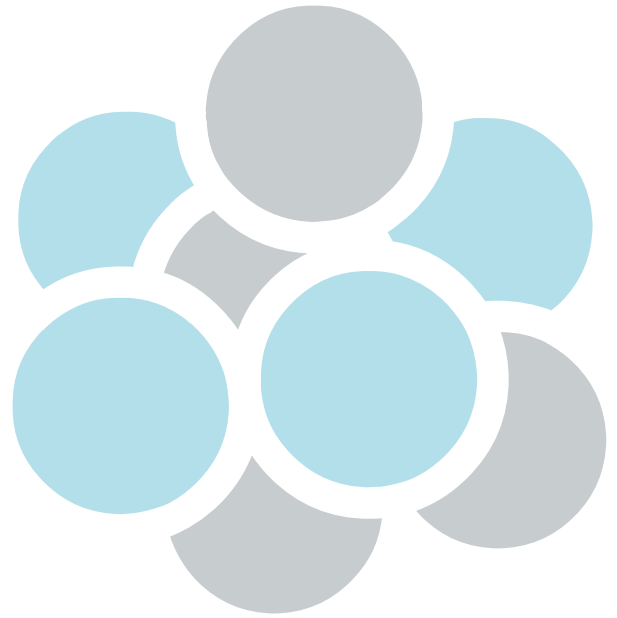
"Cutting our research while offshore spending exceeds ours is to abdicate leadership permanently. This type of error is not reversible, and we will need to resign ourselves as a nation to the consequences."

Associate Professor from the University of Minnesota

Scientific research is a global enterprise. However, over the past three years, most countries have increased their investments in research, while the U.S. has reduced its investments. When asked about our global competitors, 85 percent of survey respondents said reduced federal investments have allowed other nations to catch and pass the U.S. in scientific research. Furthermore, nearly one in five survey

respondents said they were considering moving to another country to continue their scientific career. This means the federal government would invest in the training of young scientists only to have them move to another country to compete against American scientists for the breakthroughs of tomorrow. Such a scenario would be a major blow to our national scientific enterprise.





Scientists speak about budget cuts and the loss of the federal investment in scientific research

"Our fusion experiment, with around 120 people, is being terminated. (Thirty-five) layoff notices have been given, including (ones for) scientists with decades of experience. Many more are expected soon. The field is in decline across the U.S. The choices are changing fields or leaving the country."

– Principal Research Scientist from the Massachusetts Institute of Technology Plasma Science and Fusion Center

"I have just laid off my technician and will lose my postdoc in six months. My Ph.D. students need funds to finish their degrees, and now they are working in the lab without pay. The lab may have to be closed. I will move my lab to China."

– Professor at George Mason University in Virginia

"As a society, we cannot afford to allow this drain of talent to move to other nations; nor can we afford to have other nations surpass us in areas that were pioneered in this country."

– Professor from the University of Wyoming

"I have been a professor for over 30 years. This is the most devastating funding situation I've ever seen. I have had multiple grants that received outstanding scores but were not funded. It is extremely discouraging. Many of my colleagues have retired early, and I personally know three younger colleagues who have moved to other countries. If we don't immediately reverse this trend, we will definitely become a second-rate nation in scientific leadership and advancement."

– Faculty biologist from Texas



Conclusion

The American scientific research enterprise is comprised of dedicated people using cutting-edge technologies to answer important scientific questions. This, combined with a strong, sustained federal investment in scientists and their research, has established the U.S. as the global leader in scientific and technological advancement. However, flat budgets and sequestration have put a significant strain on scientists to pursue the important research that will uncover tomorrow's cures and technologies. And now, the U.S. scientific community is approaching a point where these short-sighted budgeting techniques will irreversibly damage the research enterprise in this nation.

Scientists are spending more time writing grant applications but receiving fewer grant dollars. And only 2 percent of these scientists report that their institution or business contributes enough money to make up for this budget shortfall. Private companies and organizations have neither the funds nor the desire to fill the void caused by this reduction in the federal investment in research. Thus, insufficient funding from the federal government threatens to shutter the labs that serve as the incubators of discovery thereby putting even more scientists out of work.

However, all is not lost.

More than half of all survey respondents have had difficulty acquiring grants, witnessed colleagues losing their jobs and turned away promising young researchers from their labs. Nevertheless, in the face of such adversity, nearly 95 percent of respondents indicated they want to pursue careers as scientists so that they can attempt to make the breakthroughs and discoveries that will shape our society for decades to come. This dedication to a career in science and the enthusiasm for scientific discovery is a quality inherent to the American scientific research enterprise. But a strong federal investment in research is required to harness this enthusiasm to convert it into the cures and technologies of tomorrow.

Other countries are increasing their investments in scientific research while the American investment declines. However, scientists from all over the world still come to the U.S. to learn how to conduct groundbreaking scientific research. The federal government must invest in the American scientific endeavor by increasing the budgets of federal science funding agencies to ensure American

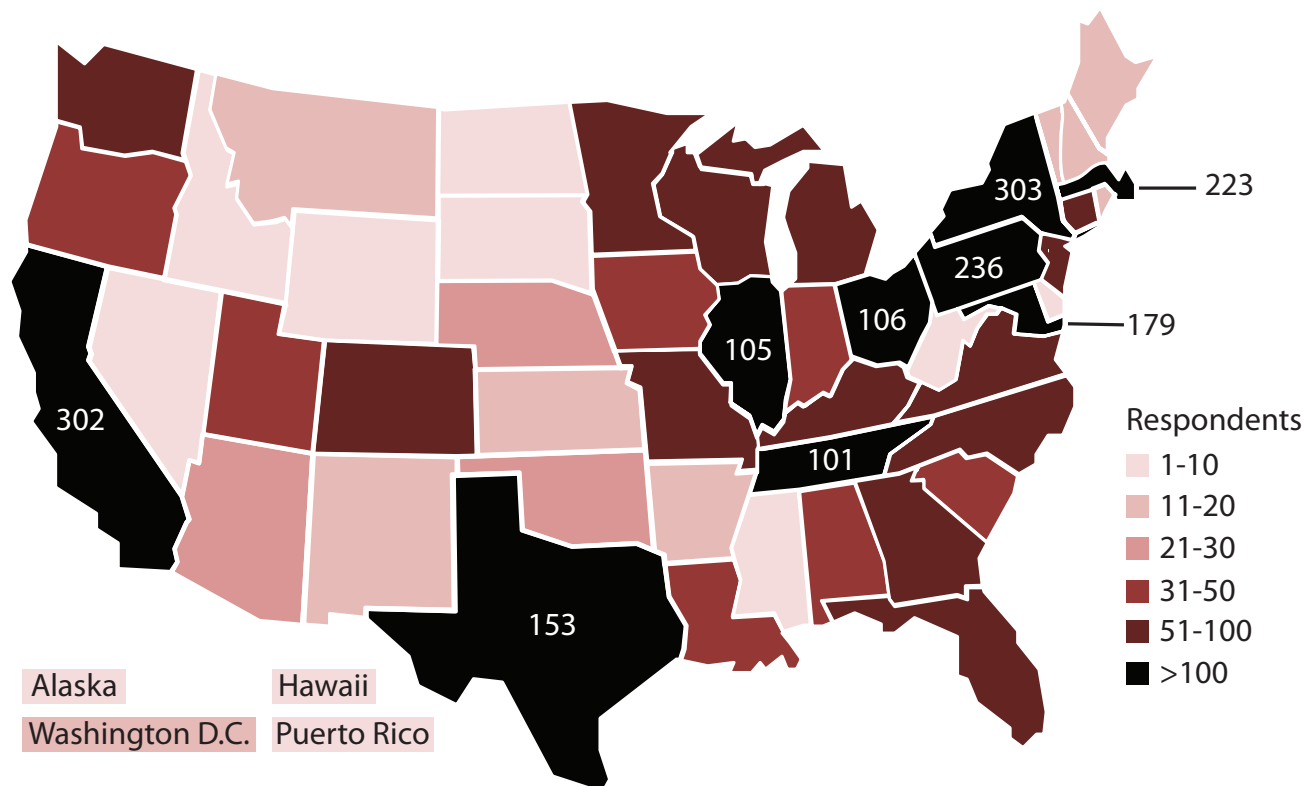
and foreign scientists alike are conducting their innovative research, establishing businesses and commercializing their discoveries in the U.S.

Scientists across the country recognize the need for targeted cuts to federal spending, but the negative effect of flat budgets and sequestration on research funding agencies has been felt across the country in all scientific disciplines. Scientific research cannot survive a stop-and-start funding environment; pauses in research funding often cause scientific results to become unusable sets of data. The federal government must find a targeted approach to overcome our nation's debt and deficit problem without harming the investments that invent new technologies, spur economic growth and save American lives. American scientists are willing and able to explore new scientific frontiers and use their discoveries for the betterment of the country. A critical first step for scientists in the U.S. to meet their potential is for the federal government to overturn sequestration and return to its strong, sustained investment in American scientists, research and discovery.



About the Nondefense Discretionary Science Survey

The American Society for Biochemistry and Molecular Biology, along with 15 other scientific organizations, conducted a nationwide, online survey during June and July of 2013. The survey's purpose was to gather information from scientists in all fields about recent budget changes at federal science funding agencies. Furthermore, this survey gave scientists from every field a chance to voice how budget cuts have affected their research efforts. Over 3,700 scientists, hailing from every state in the union including Washington D.C. and Puerto Rico, responded to the survey.

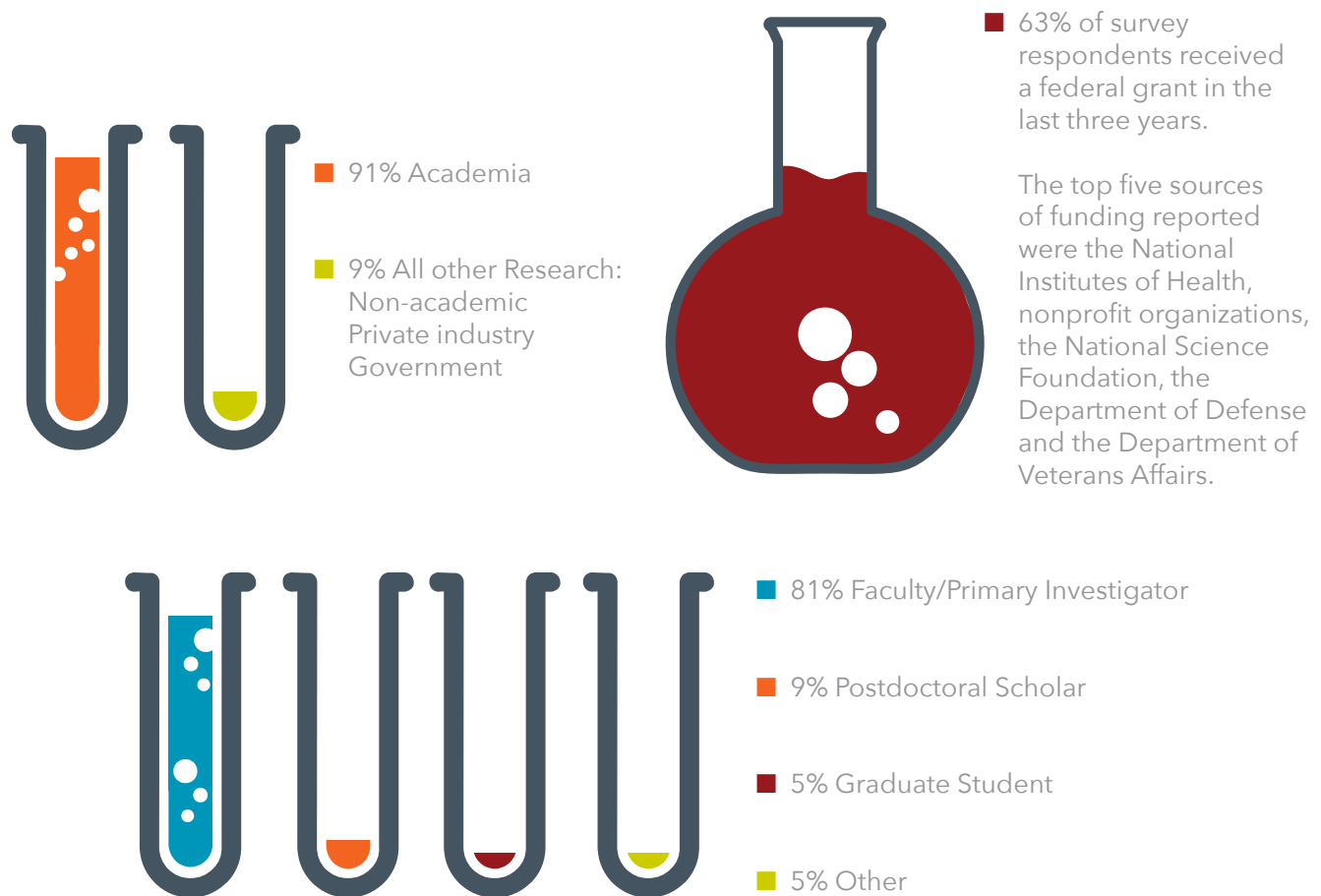




Appendix continued

While all research sectors and career stages were represented in the responses, the majority of respondents was from academia and held faculty positions.

While nearly every scientific field was represented in our survey, the top five fields with the most respondents were biology, chemistry, mathematics, education and social and behavioral science.





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